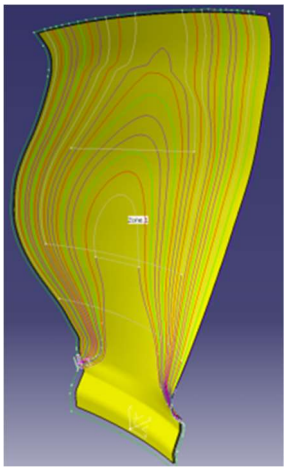
SAMULET II P4 - Next Generation Composites

Rolls-Royce (Lead), GKN Aerospace, and National Composites Centre (NCC)

Project details:

Rolls-Royce is developing a composite fan system for deployment in future civil gas turbine engines. The primary aim of a composite fan system is to deliver a significant weight saving. The blades and associated composite engine casings will form part of the new CTi fan system that could reduce weight by up to 1,500lb per aircraft, the equivalent of carrying seven more passengers and their luggage. This enables substantial improvements in fuel consumption (SFC), thereby contributing to reduced emissions and achievement of the ACARE targets (ACARE Flightpath 2050 International Environmental Targets to significantly reduced aviation CO2, NOX, and Noise by 2050).

This project sought to develop, understand and demonstrate aspects of manufacturing technologies required for the production of composite fan blades ranging in length from 60" to 140". Specific areas of research included: cost reduction; development of manufacturing methods for structural metalwork to very strict tolerances; and improvements to blade assembly techniques.



This project raised the Manufacturing Capability Readiness Level (MCRL) to 4, enabling improvements in composite laminate conformance and overall blade dimensional conformance, resulting in blades which offer improved aerodynamic performance and resistance to impact from foreign bodies.

Stability and technical capability of the manufacturing process have been demonstrated under controlled conditions. The associated manufacturing Key Process Variables (KPVs) have been identified and a strategy for KPV control has been defined. The rate of manufacture for defined components has been demonstrated using the defined manufacturing process. In addition, the associated principle running costs (including consumables, energy and labour requirements) have been defined along with requirements for capital or tooling investments to adopt the manufacturing process.

Additionally, methods to improve integration of blade aerodynamic geometric design and automated instruction for composite preform manufacture were developed and formally captured in process definitions.

Table 1: Summary of the project grant details

Project	Funding	Lead Partner	No. of Partners	Partner Composition	Duration
110103 Next Generation Composites	Total: £17.1m Grant: £6.8m	Rolls-Royce	3	2 Large companies, 1 Catapult	Jan 2012 – Dec 2014

Table 2: Summary of the project focus areas

ATI Value Streams		ATI Enablers		ATI Attributes		Strategic Horizon	
Whole Aircraft		Aerodynamics		Safety		Secure	
Structures		Manufacturing	x	Cost	x	Exploit	x
Propulsion	x	Materials	x	Environment		Position	
Systems		Infrastructure		Fuel Burn	x		
		Process and Tools	x	Operational Needs			
				Passenger Experience			

Technology Achievements:

The consortium has performed research into the fundamental understanding of how composite materials behave. This understanding can be applied by Rolls-Royce to support adoption of composite technology to new products, thereby offering opportunity to lower product weight or cost and offer the required functional and mechanical properties.

The project has greatly developed Rolls-Royce understanding of composite manufacturing technology. Knowledge and experience of the best means of automating lay-up of composite material and how to effectively and efficiently provide reinforcement of component structural integrity (e.g. through thickness reinforcement) are aspects of composite manufacturing that could be applied to components other than aero-blades in the future.

Through developing the fundamental understanding of all the key process variables for all composite blade manufacturing processes, the consortium have achieved a step change in the rigour of process control. Additionally, significant improvements in cycle time have been secured - for example the debulking process, used to remove unwanted variability from design geometry during the composite lay-up process, has been reduced in time by 60%.

The novel through-thickness-reinforcement method developed during this project has the potential for use in a wide range of applications, not only in improving the damage tolerance of the fan blade, but also a lower cost and more flexible joining technique for composite and dissimilar materials.

"Working with Rolls-Royce… has benefited the (NCC) in terms of improving the technical capability of NCC resource and has demonstrated [that] the NCC can deliver technically complex projects, resulting in substantial [projects] being won from Rolls-Royce."

Matt Hocking, *NCC Technology Programme Manager*

Table 3: Summary of the technology achievements

Project	Performance Improvements	TRL Progression
110103 Next Generation Composites	• Fundamental understanding of all key process variables for all composite blade manufacturing processes. • 60% improvement in cycle time for debulking process. • Effective and efficient reinforcement of component structural integrity.	MCRL2 to MCRL4

Economic Impact:

Rolls-Royce is developing a new, pre-production facility to test these manufacturing techniques in conjunction with the National Composites Centre in Bristol, creating a hub of composite knowledge. It is expected that 120 jobs will be secured by the end of 2019 thanks to the investment in the aforementioned facility; the majority of those being new jobs. In addition to this, the facility will support the ongoing scope of research and development in gas turbine composite manufacturing technologies.

In the UK, 30 people have been employed directly by GKN Aerospace on this project. In the supply chain it is estimated that a further 20 jobs have been generated. As this research is set to continue all these jobs should be secure over the next 4 years towards production. At the National Composites Centre 6 new jobs were created as a result of this project.

Focus on the composite fan technologies and manufacturing systems is vital to ensure Rolls-Royce is in the optimum position to exploit all future market and commercial opportunities. The ability to provide a competitive edge via fuel efficiency should support the growing aircraft in service market, which is forecasted to double in next 20 years to ~ 30,000 new aircraft.

Table 4: Summary of the economic impact

Project	Value created	Employment
110103 Next Generation Composites	new Advanced Manufacturing Centre Bristol	150 jobs safeguarded 26 jobs created

Next Steps:

The project significantly strengthened the relationship between Rolls-Royce and the NCC, and extremely efficient working practices were developed and adopted; significantly expanding the capability of the Centre for industrial research. This has led directly to Rolls-Royce placing further industrial research work at the Centre. Work for Rolls-Royce is now being undertaken across Aerospace, Marine and Nuclear sectors.

The project has incorporated a number of UK companies into the overall supply chain, some being Small and Medium sized Enterprises (SMEs). As a consequence of their involvement, companies have developed their capabilities and now have the opportunity to participate further in future work or to exploit capability in other markets.

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